FACILITIES INSTRUCTIONS,
STANDARDS, AND TECHNIQUES
VOLUME 5-9

MANAGEMENT AND SAFE HANDLING PROCEDURES FOR SULFUR HEXAFLUORIDE (SF_6) GAS

MARCH 2004

UNITED STATES DEPARTMENT OF THE INTERIOR
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Bureau of Reclamation facilities have many circuit breakers containing SF_6 gas as an insulating medium. SF_6 has been identified as a greenhouse gas that may be responsible for global warming. Release of SF_6 gas into the atmosphere during maintenance work or an accident must be reduced, tracked, and reported to the EPA. This document describes Reclamation's management and safe handling procedures for SF_6 gas. The document outlines Reclamation's SF_6 emission reduction goals and strategy, reporting procedures, safe handling practices, training, and risk assessment and mitigation program.

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HYDROELECTRIC RESEARCH AND
TECHNICAL SERVICES GROUP

UNITED STATES DEPARTMENT OF THE INTERIOR
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FIST 5-9

MANAGEMENT AND SAFE HANDLING PROCEDURES FOR SF_6 GAS

1. INTRODUCTION

Bureau of Reclamation (Reclamation) facilities have more than 1,000 power circuit breakers; the most modern of them use sulfur hexafluoride (SF_6) gas as an arc-interrupting/quenching and insulating agent. Breakers of this design are now the standard; for some applications, they are the only power circuit breakers available in the industry. Reclamation currently has some 65 power circuit breakers of the SF_6 design, as well as other SF_6 equipment (Appendix A). Reclamation plans to procure more SF_6 breakers in the future to meet its needs.

According to the Electric Power Research Institute (EPRI)[1], SF_6 is a synthetic gas that was developed for use as an electrical insulating medium for the power industry. Originally, its outstanding insulation characteristics were used primarily to reduce power circuit breaker interruption time; reducing interruption time enhances power system stability. As concerns escalated regarding poly-chlorinated biphenyls (PCBs) that were found in insulating oil used in older breakers, the use of SF_6 insulated breakers grew.

SF_6 is chemically inert, nonflammable, and nontoxic. Although SF_6 gas is not detrimental to the ozone layer, it is a highly potent greenhouse gas. It is 23,900 times more effective at trapping infrared radiation than carbon monoxide and is stable in the atmosphere for some 3,200 years. Although the percentage of SF_6 found in the atmosphere is relatively small, the rate of growth is alarming.

Currently, there is no Federal legislation curtailing the use of SF_6. However, the Environmental Protection Agency (EPA) sponsors and facilitates a program for a voluntary reduction of SF_6 emissions within the electric power industry. This program provides a forum for EPA and the electric power industry to work together to reduce SF_6 emissions to technically and economically feasible levels, thereby helping to reduce global climate change. Implied is that if voluntary programs are not successful, legislation may be required to restrict the use of SF_6. Restricting the use of SF_6 would be extremely inconvenient to the power industry, including Reclamation and the Federal Power Marketing Administrations.

Although Reclamation has not signed a memorandum of understanding with EPA establishing official compliance with the program, Reclamation will voluntarily pursue a program of SF_6 management and handling that will help reduce SF_6 emissions and promote safety for employees and the public.

For more information on EPA's SF_6 Emissions Reduction Partnership for Electric Power Systems, visit its website at <www.epa.gov/highgwp1/sf6.>

[1] "SF6 Gas Condition Assessment and Decontamination – Technical Report," June 2000, and "Practical Guide to SF6 Handling Practices," February 2002, both by the Electric Power Research Institute, Palo Alto, California.

2. SCOPE

Use of SF_6 circuit breakers and other SF_6 equipment does not come without consequences. In addition to the environmental concerns addressed in the Introduction, SF_6 gas and gas byproducts pose some risk to personnel.

SF_6 gas is heavier than air. In enclosed areas, such as in powerplants, it can displace breathable air. The toxic byproducts released when SF_6 gas interrupts the arc plasma in a circuit breaker are also of concern. Decomposition products in the form of metallic fluoride powder are toxic to humans who breathe or touch them, and adequate personal protective equipment (PPE) and training are essential for personnel safety.

This FIST volume outlines the basic requirements for SF_6 management and handling at Reclamation power facilities to address environmental and safety issues. Key elements include:

- Establishing and progressing toward local and Reclamation SF_6 emission reduction goals that meet EPA guidelines
- Developing and maintaining local records and reporting annually
- Developing and maintaining a local gas-handling plan that minimizes release of SF_6
- Following guidelines developed and used by most of the power industry worldwide
- Providing proper training in recycling, using, handling, transporting, containing spills, and reporting SF_6 releases
- Developing and maintaining a local SF_6 and SF_6 byproduct catastrophic release emergency action plan
- Developing and using an SF_6 risk assessment and mitigation strategy
- Procuring electrical equipment that is “ultra-low leakage” and performing site installation that follows all environmental and safety considerations

Although most Reclamation SF_6 equipment currently in service is located outside of powerplants and, therefore, may result in lower gas concentrations, safety and environmental precautions still apply, and a local SF_6 plan is essential.

3. RESPONSIBLITY

The Power Resources Office, D-5400, is Reclamation’s lead office for addressing corporate SF_6 management issues and any coordination with EPA. Area and project offices are responsible for implementing adequate SF_6 management and handling practices to comply with this FIST volume and any applicable State and Federal regulations and statutes. Specific responsibilities are listed below.

Power Resources Office, D-5400

- Provide corporate guidance to field offices on current SF_6 regulations, statutes, policy, and practices
- Provide liaison with EPA, power marketing administrations, and other utilities as part of Reclamation's voluntary and unofficial participation in the EPA "SF_6 Emissions Reduction Partnership for Electric Power Systems"
- Establish Reclamation SF_6 emission reduction goals
- Report Reclamation's SF_6 status to EPA, including emission reductions, when appropriate

Area/Project/Regional Office

- Establish and accomplish office SF_6 emission reduction goals
- Develop, maintain, and execute a local SF_6 Management and Safe Handling Plan in accordance with this FIST volume and EPA requirements
- Report annually to the Power Resources Office the status of the local SF_6 program
- Establish a schedule for accomplishing the requirements of this FIST volume and a process for peer reviewing generated documents

4. MANAGEMENT PLAN

Each Reclamation facility with SF_6 equipment will develop an SF_6 Management and Handling Plan that clearly defines how SF_6 is to be managed locally. The plan will include:

- An SF_6 emission reduction goal and a strategy for accomplishing it
- An inventory of all SF_6 equipment
- A strategy for measuring changes in SF_6 inventory (and, thus, leakage) for tracking and reporting purposes
- A reporting process to advise the Power Resources Office, D-5400, of the current status of the local SF_6 plan
- An SF_6 Gas Safe Handling Procedure that is compliant with EPRI guidelines
- A training plan for staff engaged in SF_6-related work
- A catastrophic-release plan
- A risk assessment and mitigation strategy

- A commitment to recycling, disposal, environmental protection, transportation, and storage consistent with applicable regulations, laws, and industry best practices

The existence and adequacy of SF_6 Management Plans will be verified under the management portion of the Reclamation Power Review of Operation and Maintenance (O&M) Program.

5. EMISSION REDUCTION GOALS

A recent study indicated that Reclamation annually loses to emissions approximately 1,300 pounds of SF_6, out of a nameplate and storage capacity of some 16,500 pounds (or approximately 7.9 percent). Emissions result from properly functioning equipment (because of static and dynamic operation), from leakage (because of old or deteriorated gaskets and seals), and from gas escaping into the atmosphere when gas is either transferred into equipment or extracted from it for disposal, recycling, or storage.[2]

Reclamation's goal is a 10-percent annual reduction in emissions from 2003 levels (a 40-percent reduction by 2007), where technically and economically feasible. This reduction will be achieved by replacing existing SF_6 breakers with "ultra-low" leakage breakers and by using more effective handling practices. Emission reduction goals beyond 2007 will be based on progress to date and emerging utility practices developed before that year.

Each Reclamation office with SF_6 equipment will establish written emission reduction goals and a strategy to support the Reclamation goal, including:

- Achieving a 10-percent annual reduction in leakage (from 2003 levels), where technically and economically feasible
- Replacing older, higher-emission SF_6 equipment with newer, "ultra-low" leakage designs
- Refurbishing existing equipment to meet "ultra-low" leakage criteria
- Improving maintenance and construction practices to control or reduce emissions
- Replacing or repairing existing equipment seals, gaskets, alarms, gages, monitoring devices, etc., to reduce leakage and allow for proper monitoring

6. EQUIPMENT INVENTORY

Each Reclamation office with SF_6 equipment will inventory all SF_6 equipment—including gas carts—to identify equipment designation, location, and nominal quantity of SF_6 in pounds. Equipment that is "sealed for life" or contains less than 15 pounds of SF_6 is exempt from this inventory.

[2] Definitions of emission sources are from Bonneville Power Administration.

Appendix A is a recent inventory of SF_6 equipment known to be at Reclamation facilities. This list should be considered informational only and must be supplemented with an official inventory.

7. EMISSION MEASUREMENT

According to EPRI, leakage for a sound SF_6 installation should be less than 1 percent annually. At least annually, each Reclamation office with SF_6 equipment will perform the required SF_6 inventory measurement using the protocol defined in Appendix B.

8. REPORTING REQUIREMENTS

Each Reclamation office with SF_6 equipment will report annually, by January 1, the status of the local SF_6 program, including the amount of emission in pounds and details of any catastrophic release. The reporting protocol and form found in Appendix B should be used for reporting purposes.

The Power Resources Office, D-5400, will report the status of the Reclamation SF_6 program to EPA, when appropriate, using the same protocol and format as shown in Appendix B.

In the first annual report to the Power Resources Office, due June 1, 2004, each office with SF_6 equipment will provide an update to the inventory in Appendix A. The update will establish a baseline of Reclamation's SF_6 equipment.

9. SAFE HANDLING PROCEDURES FOR SF_6 GAS

To achieve SF_6 emission reduction goals and to enhance employee and public safety, safe handling procedures must be developed and followed.

Existing SF_6 circuit breakers at Reclamation facilities were bought and installed with little consideration beyond that found in the manufacturer's instruction book and the limited information in the previous version of this FIST volume. Existing maintenance practices have developed in accordance with this limited knowledge. Better construction and maintenance handling procedures for SF_6 must be developed using today's accepted practices.

There are many technical considerations and procedures that must be taken into account for handling SF_6 gas safely. A comprehensive discussion of these requirements is included in a document entitled, "Practical Guide to SF_6 Handling Practices – Technical Report," Electric Power Research Institute, Palo Alto, California (February 2002).

Rather than re-creating extensive SF_6 handling procedures in this FIST volume, Reclamation endorses the EPRI document as the basis for safe handling procedures for

SF_6 gas. Local SF_6 management programs should incorporate all considerations from the EPRI document including:

- Equipment classification
- Risks, warning signs, and written instructions
- Handling procedures
- Personal protective equipment
- Disposal and environmental protection
- Transportation and storage

Copies of the EPRI "Practical Guide to SF_6 Handling Practices" were made available to Reclamation power offices with the distribution of the 2004 revised version of this FIST volume. Additional copies of the EPRI document may be acquired by contacting:

EPRI
3412 Hillview Avenue, Palo Alto, CA 94304
PO Box 10412, Palo Alto CA, 94303
1-800-313-3774 (select option 2)
<askepri@epri.com>
<www.epri.com>

Mention that you are with the Bureau of Reclamation, which is a member of EPRI through the Western Area Power Administration. Please reference Report No. 100945. There is no charge for EPRI documents produced in membership target areas. EPRI documents may also be obtained online at <www.epri.com>. If you are not presently an EPRIWEB user, you can request a password at <www.epri.com> by clicking on the "New Users Register" area (below the customer log-in box). At the next screen, follow the directions and fill in the information requested. EPRI documents acquired in this way are for Reclamation and Reclamation-contractor use only.

In addition to the above EPRI document, reference should be made to manufacturers' instructions when adopting an SF_6 safe handling plan.

10. TRAINING

Only properly qualified and trained personnel should work with SF_6 and SF_6 equipment. Each Reclamation office with SF_6 equipment will develop and maintain an SF_6 training plan.

Training in proper handling procedures should always be provided by the contractor who furnishes and installs SF_6 equipment. SF_6 training in operation, maintenance, and safety procedures is available from the power marketing administrations (Western Area Power

Administration and Bonneville Power Administration), who deal with SF_6 equipment extensively. Third-party commercial providers of SF_6 training include, but are not limited to:

- DILO Company, Inc. <www.dilo.com>
- AVO Training Institute <www.avotraining.com>
- Associated Training Corp. <www.atc-trng.com>
- Mitsubishi Electric Power Products, Inc. <www.meppi.com/service.asp>

Refresher training in SF_6 handling procedures should be accomplished annually after initial comprehensive training.

Since SF_6 enclosures should be treated as confined space, training in confined space practices is required to ensure that staff are aware of the risks and take proper precautions. Confined space training is available from established Reclamation sources.

11. CATASTROPHIC RELEASE PLAN

A catastrophic release of SF_6 is the result of sudden, severe failure—and possible destruction—of the equipment containing the gas. Catastrophic release will introduce into the environment SF_6 gas and SF_6 decomposition byproducts, in gaseous and powder form, complicating what might already be a bad situation, such as explosive porcelain failure, fire and smoke, debris, and unit outage.

A catastrophic release of SF_6 may be caused by an incident that requires reporting under the Reclamation Power O&M Incident Evaluation and Reporting Program (Directive and Standard FAC 04-02). The incident should also be reported immediately through proper channels via the Reclamation Emergency Notification Systems (ENS).

In addition to protective and mitigation measures described in EPRI's "Practical Guide to SF_6 Handling Practices" (section 5.4), each office with SF_6 equipment must have a plant-specific SF_6 Catastrophic Release Plan, including:

- Location and use of protective clothing and self-contained breathing apparatus
- Location and awareness of material safety data sheets (MSDS)
- Identification of areas where gas and powder might collect
- Location of air intakes and an evaluation of their potential to spread gases
- Consideration of additional ventilation to offset the presence of decomposition gases
- References to the Reclamation Emergency Notification System, the responsible Hazardous Materials and Safety Offices, and to a qualified industrial hygienist that is knowledgeable and trained in SF_6 hazard evaluation and clearance re-entry criteria.

- A list of contractors able to provide cleanup, decontamination, and disposal
- Identification of the appropriate state environmental office for notification of release, where required
- Decontamination and neutralization procedures and materials and identification of sources of these materials or locations where they are stockpiled. As a minimum, these procedures must include decontaminating plant and power equipment and personnel, including neutralizing wash; vacuuming powder from clothing; neutralizing all test and maintenance equipment; and appropriately disposing of clothing and wipes. Decontamination procedures must be adequate to return the equipment, the plant, and all personnel to a decontaminated state

12. RISK ASSESSMENT AND MITIGATION

Each Reclamation office with SF_6 equipment will develop and execute an SF_6 risk assessment and mitigation strategy. This assessment and strategy will include:

- Risk of SF_6 emission (leakage and catastrophic release) to plant staff by identifying how and where gas could collect
- Review and proper distribution of MSDS for SF_6 and SF_6 decomposition products and communication of risks to staff
- Use of adequate, properly calibrated SF_6 gas detectors by maintenance staff to indicate presence or absence of SF_6 and SF_6 byproducts. The slight reduction of oxygen, measured by an oxygen meter, may not reflect the concentration of hazardous byproducts that may be present
- Permanent installation and use of SF_6 gas monitoring alarms, located where SF_6 gas could accumulate
- Proper use and response to SF_6 gas pressure or density alarms that are furnished with SF_6 equipment
- Strategy for evacuating SF_6 gas from accumulation locations
- Use of SF_6 warning signage in accordance with Section 4 of EPRI's "Practical Guide to SF_6 Handling Practices"
- Adequacy and availability of PPE, including protective clothing and respiratory devices. See Section 6 and Appendix B of the EPRI guide

13. RECYCLING, DISPOSAL, ENVIRONMENTAL PROTECTION, TRANSPORTATION, AND STORAGE

Where technically and economically feasible, Reclamation offices will recycle (recover and reuse) SF_6 gas.

Reclamation will comply with all applicable Federal and State regulations and laws regarding disposal, environmental protection, transportation, and storage of SF_6 gas, gas byproducts, and contaminated equipment, tools, materials, clothing, and PPE. Refer to Sections 7 and 8 of the EPRI "Practical Guide to SF_6 Handling Practices" and Reclamation Safety and Health Standards for guidance.

14. PROCUREMENT OF SF_6 EQUIPMENT

When procuring SF_6 equipment, consideration must be given to mitigating future gas leakage. Procurements should address the following:

- Acquisition of sealed-for-life and "ultra-low-leakage" equipment, where feasible
- Acquisition and application of all available gas leakage monitoring systems, such as overpressure, refilling, and low-pressure alarms
- Acquisition and application of SF_6 gas and SF_6 decomposition product detectors, both portable (for maintenance use) and permanently installed (for plant alarm)
- Acquisition of an adequate "gas cart" for proper filling and evacuating of SF_6 equipment
- Provision by the contractor of adequate training in SF_6 operation and maintenance
- Provision by the contractor of appropriate leakage and spill containment and cleanup equipment and supplies

15. GAS CARTS

Gas handling apparatus (i.e., gas carts) are essential for filling and evacuating SF_6 equipment. See EPRI "Practical Guide to SF_6 Handling Practices," section 5.1.1 for more information. Reclamation SF_6 gas carts should conform to EPRI guidelines in construction and be operated and maintained using EPRI's recommendations.

Care should be exercised when handling and transporting gas bottles and carts because residual gas can be present. Proper evacuation procedures should be followed.

Gas carts require adequate maintenance and testing. Gas carts should be identified in MAXIMO as an individual piece of equipment requiring preventive maintenance. Job plans and work orders should be developed, with maintenance steps, in accordance with section 5.1.1 of the EPRI guidelines, including:

- Cart preparation and conditioning
- Loss of pressure check
- Loss of vacuum check
- Scrubber testing
- Flowmeter testing
- Vacuum pump maintenance
- Moisture testing
- SF_6 percentage testing
- Byproduct tube inspection

Maintenance of gas carts will be verified under the electrical portion of the Reclamation Power Review of O&M Program.

APPENDIX A

SF_6 Location At Reclamation Facilities – 2003

Table 1.—SF_6 Location in and Near Reclamation Facilities - 2003

Region	Plant	Equipment type	Equipment designation	Pounds of SF_6	Maintained by
PN	Coulee 500 switchyard	Circuit breaker	PCB 2092 G-20	1,570	Reclamation
PN	Coulee 500 switchyard	Circuit breaker	PCB 2192 G-21	1,570	Reclamation
PN	Coulee 500 switchyard	Circuit breaker	PCB 2292 G-22	1,570	Reclamation
PN	Coulee 500 switchyard	Circuit breaker	PCB 2496 G-24	1,570	Reclamation
PN	Coulee 500 switchyard	Gas cart	Limco PET2015	200	Reclamation
PN	Coulee 500 switchyard	Gas cylinders	UN 1080	30x115	Reclamation
PN	Coulee 230 switchyard	Circuit breaker	PCB 6084 Bus Tie	330	Reclamation
PN	Coulee 230 switchyard	Circuit breaker	PCB 6582 CSY #1	330	Reclamation
PN	Coulee 115 switchyard	Circuit breaker	PCB 2172 Trans. Bkr.	200	Reclamation
PN	Coulee 115 switchyard	Circuit breaker	PCB 2372 LC #6	200	Reclamation
PN	Coulee 115 switchyard	Gas cylinder	UN 1080	115	Reclamation
PN	Coulee PG Plant	GIS	KP10A 3080, 3180, 3280, 3081, 3181	400	Reclamation
PN	Coulee PG Plant	Gas cylinders	UN 1080	2x115	Reclamation
PN	Coulee industrial area	Switch	UIAHA2	13.1	Reclamation
PN	Coulee industrial area	Gas cylinders	UN 1080	2x115	Reclamation
PN	Green Springs	Circuit breaker	JX1A	25	Reclamation
PN	Palisades	Circuit breaker	1062	115	Reclamation
PN	Minidoka	Circuit breaker	562	80	Reclamation

Table 1.—SF_6 Location in and Near Reclamation Facilities - 2003

Region	Plant	Equipment type	Equipment designation	Pounds of SF_6	Maintained by
PN	Minidoka	Circuit breaker	662	80	Reclamation
PN	Minidoka	Gas cart			Reclamation
PN	Hungry Horse	Circuit breaker	JY1A / 2182	95	BPA
PN	Hungry Horse	Circuit breaker	JY2A / 2282	95	BPA
PN	Hungry Horse	Circuit breaker	JY3A / 2382	95	BPA
PN	Hungry Horse	Circuit breaker	JY4A / 2482	95	BPA
PN	Hungry Horse	Gas cylinder		5x120	BPA
MP	New Melones	Gas cart			Reclamation
MP	New Melones	Gas cylinder			Reclamation
MP	New Melones	Circuit breaker	122	15.8	Reclamation
MP	New Melones	Circuit breaker	222	15.8	Reclamation
MP	Folsom	Circuit breaker	162	115	Reclamation
MP	Folsom	Circuit breaker	282	140	Reclamation
MP	Folsom	Circuit breaker	382	140	Reclamation
LC	Hoover	Circuit breaker		100	Reclamation
LC	Hoover	Circuit breaker		100	Reclamation
LC	Hoover	Circuit breaker		100	Reclamation
LC	Hoover	Circuit breaker		100	Reclamation
LC	Hoover	Circuit breaker		100	Reclamation
LC	Hoover	Circuit breaker		100	Reclamation
LC	Hoover	Circuit breaker		100	Reclamation
LC	Hoover	Circuit breaker		100	Reclamation
LC	Hoover	Circuit breaker		100	Reclamation
LC	Hoover	Circuit breaker		100	Reclamation
LC	Hoover	Circuit breaker		100	Reclamation
LC	Hoover	Circuit breaker		100	Reclamation
LC	Hoover	Circuit breaker		100	Reclamation

Table 1.—SF_6 Location in and Near Reclamation Facilities - 2003

Region	Plant	Equipment type	Equipment designation	Pounds of SF_6	Maintained by
LC	Hoover	Circuit breaker		100	Reclamation
LC	Hoover	Circuit breaker		100	Reclamation
LC	Hoover	Circuit breaker		100	Reclamation
LC	Hoover	Circuit breaker		100	Reclamation
LC	Hoover	Circuit breaker		100	Reclamation
LC	Hoover	Gas cylinder		119.1	Reclamation
LC	Hoover	Gas cylinder		117.3	Reclamation
LC	Hoover	Gas cylinder		116.5	Reclamation
LC	Hoover	Gas cylinder		50.5	Reclamation
UC	Glen Canyon	Circuit breaker		36.74	Reclamation
UC	Glen Canyon	Circuit breaker		36.74	Reclamation
UC	Glen Canyon	Circuit breaker		36.74	Reclamation
UC	Glen Canyon	Circuit breaker		36.74	Reclamation
UC	Glen Canyon	Circuit breaker		36.74	Reclamation
UC	Glen Canyon	Circuit breaker		36.74	Reclamation
UC	Glen Canyon	Circuit breaker		36.74	Reclamation
UC	Glen Canyon	Circuit breaker		36.74	Reclamation
UC	Glen Canyon	Gas cart	Dilo D320		Reclamation
UC	Glen Canyon	Gas cylinder		90	Reclamation
UC	Glen Canyon	Gas cylinder		5	Reclamation
UC	Pinabete Substation	Circuit switch		15	BIA
UC	Gallegos PP	Circuit switch		15	BIA
UC	Gallegos PP	Circuit switch		15	BIA
UC	Gallegos PP	Circuit switch		15	BIA
UC	PP A0.8L	Breaker		15	BIA
UC	PP A0.8L	Breaker		15	BIA
UC	PP A0.8L	Breaker		15	BIA

Table 1.—SF_6 Location in and Near Reclamation Facilities - 2003

Region	Plant	Equipment type	Equipment designation	Pounds of SF_6	Maintained by
UC	PP A0.8L	Gas cylinder		12	BIA
UC	PP A0.8L	Gas cylinder		13	BIA
GP	Mt. Elbert	Circuit breaker	U1A	15.8	Reclamation
GP	Mt. Elbert	Circuit breaker	U2A	15.8	Reclamation
GP	Mt. Elbert	Circuit breaker	JV2A	132	WAPA
GP	Mt. Elbert	Circuit breaker	JV3A	132	WAPA
GP	Mt. Elbert	Gas cart	Cryoquip 2BC	115 capacity	Reclamation
GP	Green Mountain	Circuit breaker	JZ1A	15	Reclamation
GP	Green Mountain	Circuit breaker	JZ2A	15	Reclamation
GP	Green Mountain	Circuit breaker	JZ3A	15	Reclamation
GP	Green Mountain	Circuit breaker	JZ5A	15	Reclamation
GP	Green Mountain	Gas cylinder	Four cylinders	4x20	Reclamation
GP	Flatiron	Circuit breaker	U1A2	15.8	Reclamation
GP	Flatiron	Circuit breaker	U1A3	15.8	Reclamation
GP	Flatiron	Circuit breaker	U2A2	15.8	Reclamation
GP	Flatiron	Circuit breaker	U2A3	15.8	Reclamation
GP	Flatiron	Gas cart	Cryoquip HC series	0	Reclamation
GP	Flatiron	Gas cylinders	Two cylinders	2x5	Reclamation
GP	Mary's Lake	Circuit breaker	JYA	77	Reclamation
GP	Seminoe	Circuit breaker	JY2A	60	WAPA
GP	Seminoe	Gas cart		115 capability	Reclamation
GP	Seminoe	Gas cylinders		2x115	Reclamation
GP	Kortes	Circuit breaker	JY1A	60	WAPA
GP	Kortes	Circuit breaker	JY4A	60	WAPA
GP	Kortes	Gas cylinders		2x115	Reclamation

APPENDIX B

SF_6 Emissions Inventory Reporting Protocol and Form

This protocol provides a template for reporting annual SF_6 emissions based on annual changes in SF_6 inventory. Use of the protocol to complete the SF_6 Emissions Reporting Form requires the following data:

- SF_6 gas in inventory at the beginning of the reporting year
- SF_6 gas in inventory at the end of the reporting year
- SF_6 gas additions to the inventory (e.g., purchases)
- SF_6 gas subtractions from the inventory (e.g., sales or returns)
- Changes in nameplate capacity

Gas in inventory refers to SF_6 gas contained in storage cylinders, gas carts, and other storage containers. **It does not refer to SF_6 gas held in operating equipment.**[3]

Gas additions and subtractions refer to SF_6 gas placed in or removed from the stored inventory, respectively. Gas additions also include SF_6 provided by equipment manufacturers with or inside new equipment.

Complete tables 1 and 2 to estimate annual emissions. Use the Comments box to describe the means used to obtain a specific quantitative value (e.g., measured, estimated using rough data, or other comments including perceived accuracy of the form entries). Add additional comment sheets if necessary.

Accounting for Acts of Nature and Other Non-Preventable Events

An act of nature (e.g., lightning or earthquake) or other nonpreventable event of equipment failure (e.g., from a severe electrical fault) that destroys or damages a piece of equipment might result in a sudden, "catastrophic" loss of SF_6 to the atmosphere.[4] If SF_6 loss to the atmosphere occurs as a result of an act of nature or other non-preventable event, this loss should be reported on the form kept separate from normal annual emissions.[5]

[3] Reporting is required only on the change in inventory, not the absolute value. This method assumes gas is being added to equipment as needed to ensure adequate insulation.
[4] The term "nonpreventable" does not include releases from properly functioning equipment (caused by static and dynamic operation) or leakage (e.g., caused by deteriorated and leaking gaskets or seals).
[5] Such an event may also require reporting according to the Power Operation and Maintenance Incident Evaluation and Reporting Program and the Emergency Notification System.

SF_6 EMISSIONS REPORTING FORM

Date:	Office:	Contact:

Table 1			
Inventory		Amount (lbs)	Comments
A	Beginning of year		
B	End of year		

Table 2		
Additions to Inventory		
	Amount (lbs)	Comments
1. Purchases of SF_6 (including SF_6 provided by equipment manufacturers with or inside new equipment)		
2. SF_6 returned to the site after off-site recycling		
C: Total Additions (add items 1 and 2)		
Subtractions from Inventory		
	Amount (lbs)	Comments
3. Sales of SF_6 (to other entities, including gas left in retired equipment)		
4. SF_6 returned to supplier		
5. SF_6 taken from storage or equipment and disposed of		
6. SF_6 taken from storage or equipment and sent off site for recycling		
D: Total Subtractions (add items 3-6)		
Change to Nameplate Capacity		
	Amount (lbs)	Comments
7. Total nameplate capacity of new equipment		
8. Total nameplate capacity of retiring equipment		
E: Change to Nameplate Capacity (subtract item 8 from item 7)		

Total Annual Emissions = A – B + C – D – E

Release from Act of Nature or Other Unpreventable Event			
Type of Event[1]	Equipment damaged	Amount released (lbs)	Comments

[1] Lightning, earthquake, electrical fault, vandalism, etc.